More Work + Energy

We'll try not to confuse Work = $\int F_{\parallel} ds$ with Weight = mg

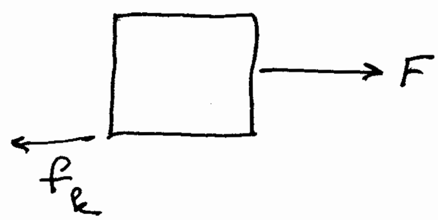
$$W = \int F_{\parallel}\, ds = \int F\, ds_{\parallel}$$

$$= F_{\parallel}\, s \quad \text{if } F = \text{const.}$$

$W = +$ if $F_{\parallel}$ + s in same direction

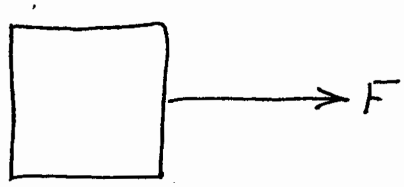
$W = -$ if opposite

We have discussed three ways that work is converted into energy

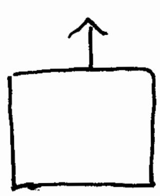


Dissipation (Heat) $= f_k \cdot s$

(There are other ways that energy is dissipated



Kinetic Energy $= \frac{1}{2} m v^2$



Potential Energy $= mgh$

(There are many kinds of Potential Energy)

Work Energy Principle

THE **NET** **WORK** DONE ON AN OBJECT IS EQUAL TO ITS CHANGE IN KINETIC ENERGY

$$W_{net} = \Delta KE$$

Back to our sliding box

$F = 750\,N$

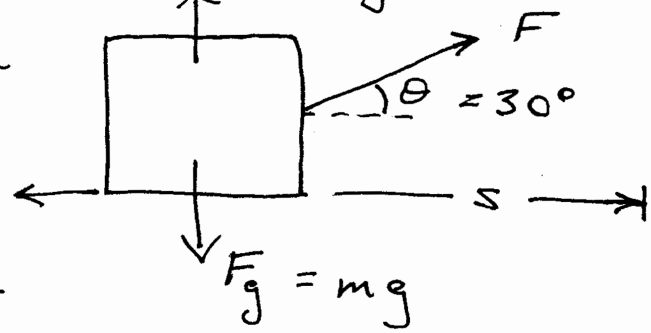
LET $m = 100\,kg$ again

Same surface as yesterday

$\mu_k = 0.045$ f_k

$v_0 = 0$

$N = F_g - F_\perp = mg - F\sin\theta$



Which forces perform work? Only F + f_k have components ∥ to displacement

Can look at this two ways

$\underline{W_{net} = \Delta KE}$

$$W_{net} = W_F + W_{f_k} + \cancel{W_{F_g}}^{F_\parallel = 0} + \cancel{W_N}^{F_\parallel = 0} = \Delta KE$$

$$= F\cos\theta \cdot s - f_k \cdot s = \Delta\left(\tfrac{1}{2} m v^2\right)$$

$$= F\cos\theta \cdot s - \mu_k (mg - F\sin\theta) \cdot s$$

$$= \left[F(\cos\theta + \mu_k \sin\theta) - \mu_k mg\right] s = \tfrac{1}{2} m \left(v^2 - \cancel{v_0^2}^{0}\right)$$

$$= [666\,N - 444\,N] \cdot 1\,m = \tfrac{1}{2} m v^2$$

$$222\,J = \tfrac{1}{2} \cdot 100\,kg \cdot v^2$$

$$v^2 = \frac{444\,J}{100\,kg} \Rightarrow \underline{v = 2.11\,m s^{-1}}$$

n.b. this is $\Delta(v^2)$ not $(\Delta v)^2$

OR

$\underline{F_{net} \cdot s = \Delta KE}$

Parenthetically, we can also work this

$$F_{net} = ma$$

$$F_{net} = 222\,N = 100\,kg \cdot a$$

$$a = 2.22\,m s^{-2}$$

$$x = \cancel{x_0}^{0} + \cancel{v_0}^{0} t + \tfrac{1}{2} a t^2 = 1\,m \qquad v = \cancel{v_0}^{0} + at$$

$$t^2 = \frac{2 \cdot 1m}{2.22\,m s^{-2}} \qquad v = 2.22\,ms^{-2} \cdot 0.95\,s$$

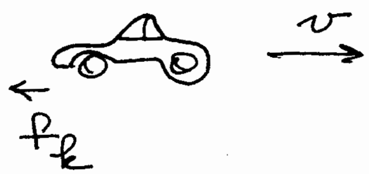
$$t = 0.95\,s \qquad = 2.11\,m s^{-1}$$

Ex #25 Car leaves skid marks 88 m $= 290'$ long

$\mu_k = 0.42$; how fast was car moving

$$\text{net } W = \text{net } F \cdot s = \Delta KE$$

What is net force on car



$$f_k \cdot s = \tfrac{1}{2} m (v_f^2 - v_0^2)$$

$$v_f = 0$$

n.b. W_f is negative

$$\tfrac{1}{2} \cancel{m} v_0^2 = -f_k \cdot s = \mu_k N \cdot s$$

$$= \mu_k \cancel{m} g\, s$$

$$v_0^2 = 2 \mu_k g s = 2 \cdot 0.42 \cdot 9.8\,ms^{-2} \cdot 88\,m$$

$$v = 27\,m s^{-1} \; (60 \ldots)$$